16. STOICHIOMETRY ATOMIC WEIGHT, MOLECULAR WEIGHT AND GMV SOLUTIONS

TEACHING TASK

JEE MAIN LEVEL QUESTIONS

1. Calculate the number of Cl^- and Ca^{2+} ions in 222 g anhydrous $CaCl_2$

   1) 3N, 6N 2) 4N, 2N 3) 10N, 5N 4)6N,3N

Answer:2

Solution:Molar mass of $CaCl_2$ = 40 + (35.5 × 2) = 111 g/mol

Moles = 222 / 111 = 2 moles

1 mole of CaClgives:

1 Ca^{2+} ion $\rightarrow$ 2 moles = 2 × N = 2N

2 Cl^- ions $\rightarrow$ 2 × 2 × N = 4N

2. Which one of the following pairs of gases contain the same number of molecules?

   1) 16 g of O_2 and 14 g of N_2 2) 8 g of O_2 and 22 g of CO_2

   3) 28 g of N_2 and 22 g of CO_2 4) 32 g of O_2 and 32 g of N_2

Answer:1

Solution:Moles of O_2 = 16 / 32 = 0.5

Moles of N_2 = 14 / 28 = 0.5

Same moles $\rightarrow$ Same number of molecules (Avogadro's Law).

3. The total number of gm-atoms of SO_2Cl_2 in 13.5g of sulphuryl chloride is

   1) 0.1 2) 0.2 3) 0.3 4) 0.4

Answer:1

Solution:Molar mass of SO_2Cl_2 = 32 + 32 + 71 = 135 g/mol

Moles = 13.5 / 135 = 0.1 moles (gm-molecules).

Atoms=5 x 0.1=0.5

no 0.5 in the options consider molecules 0.1

4. How many atoms are contained in one mole of sucrose ($C_{12}H_{22}O_{11}$)?

   1) 45 × 6.02 × 10^{23} atoms/mole 2) 5 × 6.62 × 10^{23} atoms/mole

   3) 5 × 6.02 × 10^{23} atoms/mole 4) None of these

Answer:1

Solution:Sucrose has 45 atoms per molecule (12 C + 22 H + 11 O).

Total atoms = 45 × Avogadro's number (6.02×10^{23}).

5. A sample of phosphorus trichloride (PCl_3) contains 1.4 moles of the substance. How many atoms are there in the sample?

1) 4 2) 5.6 3) 8.431×10^{23} 4) 3.372×10^{24}

Answer:4

Solution:PCl_3 has 4 atoms per molecule (1 P + 3 Cl).

Total atoms = $1.4 \times 4 \times 6.02 \times 10^{23} = 3.372 \times 10^{24}$.

6. The molecular weight of hydrogen peroxide is 34. The weight of 1 mole of H_2O_2 is

1) 34 a.m.u 2) 34 mg 3) 34 g 4) 34 kg

Answer:3

Solution:1 mole = molar mass in grams $\rightarrow$ 34 g.

7. The number of electrons in a mole of hydrogen molecule is

1) 6.02×10^{23} 2) 12.046×10^{23} 3) 3.0115×10^{23} 4) Indefinite

Answer:2

Solution: H_2 has 2 electrons per molecule.

Total electrons = $2 \times 6.02 \times 10^{23} = 12.04 \times 10^{23}$.

8. The largest number of molecules are present in

1) 34g of water 2) 28g of CO_2 3) 46g of CH_3OH 4) 54g of N_2O_5

Answer:1

Solution:Moles:

H_2O: 34 / 18 = 1.89

CO_2: 28 / 44 = 0.64

CH_3OH: 46 / 32 = 1.44

N_2O_5: 54 / 108 = 0.5

Highest moles $\rightarrow$ Most molecules.

9. The number of moles of sodium oxide in 620 g of it is

1) 1 mole 2) 10 moles 3) 18 moles 4) 100 moles

Answer:2

Solution:Molar mass of Na_2O = (2 × 23) + 16 = 62 g/mol

Moles = 620 / 62 = 10 moles.

10. Calculate the number of atoms of oxygen present in 88 g CO_2. What would be the weight of CO having the same number of oxygen atoms?

1) 224 g, 6.023×10^{23} 2) 222 g, 12.056×10^{23}

3) 120 g, 18.023×10^{23} 4) 112 g, 24.02×10^{23}

Answer:4

Solution:Step 1: CO_2

Molar mass = 44 g

Moles = 88 / 44 = 2 mol

Each CO_2 has 2 O atoms, so total O atoms = 2 mol × 2 × $6.022 \times 10^{23} = 2.4088 \times 10^{24}$

Step 2: CO

Each CO has 1 O atom, so to get same number of O atoms, need 2.4088×10^{24} CO molecules = 4 moles

Mass of CO = 4 mol × 28 g = 112 g

ADVANCED LEVEL QUESTIONS

MULTIPLE CORRECT ANSWER TYPE

11. The mass of one atom of an unknown element is $4 \times 1.66 \times 10^{-24}$g. The element is:

A) Hydrogen B) Helium C) Oxygen D) Sulphur

Answer:B

Solution:Mass of 1 atomic mass unit (amu) = 1.66×10^{-24} g

Given mass = $4 \times 1.66 \times 10^{-24}$ g

Atomic mass = 4 amu $\rightarrow$ Helium

12. The weight of ammonia molecule in grams is:

A) 17a.m.u B) 17×10^{-3}

C) $17 \times 1.66 \times 10^{-24}$g D) $17 \times 1.66 \times 10^{-27}$ Kg

Answer:C

Solution:Molecular mass of NH_3 = 14 (N) + 3 (H) = 17 a.m.u.

Conversion to grams:$1a.m.u = 1.66 \times 10^{-24}$g

Weight in grams = $17 \times 1.66 \times 10^{-24}$g

STATEMENT TYPE

1. A and R are correct R is the correct explanation of A
2. A and R are correct R is not the correct explanation of A
3. A is correct, but R is wrong 4. A is wrong, but R is correct

13. **Assertion (A):** a.m.u. is the smallest unit of mass used to measure the masses of atoms and subatomic particles.

Reason (R): 1 a.m.u.= 1.67 x 10^{-24}g

Answer:2

Solution:Assertion (A):a.m.u. is the smallest unit of mass used to measure the masses of atoms and subatomic particles.

Correct — a.m.u. (atomic mass unit) is used for atomic and subatomic particles.

Reason (R):1 a.m.u. = 1.67 × 10^{-24}g

Correct (approximate) — actual value is 1.66 × 10^{-24} g, but 1.67 × 10^{-24} g is acceptable in rounded form.

Reason (R) provides the numerical value of 1 a.m.u in grams. This value does not explain why a.m.u. is the smallest unit used for atoms and subatomic particles. The reason for using a.m.u. is the extremely small scale of atomic masses, not its specific conversion to grams.

14. **Assertion (A):** Volume of 22 grof CO_2 is 22.4 lit at STP.

Reason (R): Volume occupied by 1 mole of a gas at STP is called gram molecular weight.

Answer:5

Solution:Assertion (A): Incorrect — 22 g of CO_2 is not 1 mole.

Molar mass of CO_2 = 44 g

22 g CO_2 = 0.5 mole

Volume = 0.5 × 22.4 = 11.2 L,So, Assertion is wrong.

Reason (R): Incorrect — That volume (22.4 L) is called molar volume, not gram molecular weight.

COMPREHENSION TYPE

Relative molecular mass or molecular weight is defined as the number of times a molecule is heavier than $\frac{1}{12}^{th}$ the mass of C-12 isotope's atom.

$$RMM = \frac{\text{Average mass of one molecule}}{\text{Weight of } 1/12^{th} \text{ of C-12 atom}}$$

15. Find the number of gram molecules of hydrogen present in 1 gram molecule of methane gas.

1) 1 2) 2 3) 4 4) 8

Answer:3

Solution:The molecular formula of methane is CH_4, which means 1 molecule of methane contains 4 atoms of hydrogen.

1 gram molecule of methane (CH_4) = 1 mole of CH_4.

Since 1 mole of CH_4 contains 4 moles of hydrogen atoms, the number of gram molecules of hydrogen is 4.

16. 100 g of which gas contains of the maximum number of gram molecules?
1) SO_2 2) O_2 3) He 4) H_2

Answer:4

Solution:The number of gram molecules (moles) in a given mass is calculated as:

Number of moles=Mass/Molar Mass

To maximize the number of moles, we need the gas with the smallest molar mass.

Molar masses:

SO_2 = 32 + 16 × 2 = 64 g/mol

O_2 = 32 g/mol

He = 4 g/mol

H_2 = 2 g/mol

Hydrogen (H_2) has the smallest molar mass, so 100 g of H_2 will give the maximum number of moles

17. How many gram molecules of methane are present in 'x' g of it, where 'x' is equal to the weight of 1 gram molecule of SO_2?

1) 4 2) 8 3) 16 4) 32

Answer:1

Solution:Find the mass of 1 gram molecule of SO_2 (molar mass of SO_2):

Molar mass of SO_2=32(S)+16×2(O)=64g/mol

So, x=64g.

Find the number of gram molecules (moles) of methane (CH_4) in 64 g:

Molar mass of CH_4=12(C)+1×4(H)=16g/mol

Number of moles of CH_4=64/16 =4moles

INTEGER TYPE

18. The number of moles of water present in 90 grams of water are ____

Answer:5

Solution:The molar mass of water (H_2O) is:

Molar mass=2×1(H)+16(O)=18g/mol

The number of moles is calculated as:

Number of moles=Mass/Molar Mass=90/18=5moles

19. 200 c.c. of a gas measured at S.T.P. has a mass of 0.268g. Molecular weight of the gas is _____

Answer:30

Solution:The experimental value of 1gram molecular volume of a gas is 22.4 litre at S.T.P or 22400 ml at S.T.P.

Let x grams of gas

x gms $\rightarrow$ 22400

0.268g. $\rightarrow$ 200

200x=0.268(22400)=6003.2

x=6003.2/200=30.016

MATRIX MATCHING TYPE

20.	**Substance**	**No.of Moles**
	a) 2.3 gr of Na	1) 0.5
	b) 3 X10^{23} molecules of CO_2	2) 0.25
	c) 1.12 lit of H_2 at STP	3) 0.1
	d) 8 gr. of O_2	4) 0.05

Answer:a-3,b-1,c-4,d-2

Solution:

a) 2.3 gr of Na

moles=2.3/23=0.1

b) 3 X10^{23} molecules of CO_2

moles=3 X10^{23}/6 X10^{23}=0.5

c) 1.12 lit of H_2 at STP

moles=0.05moles

d) 8 gr. of O_2

moles=8/32=0.25moles

LEARNER'S TASK

CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's)

1. 1 amu is equal to the mass of:

A) $\frac{1}{12}$th of C - 12 atom B) $\frac{1}{14}$th of O-16 atom

C) 1g of H_2 D) 1.66×10^{-23} kg

Answer:A

Solution:1 atomic mass unit (amu) is defined as 1/12th the mass of a carbon-12 atom.

2. The weight of Helium atom in grams is:

A) 2 B) 4 C) 6.64×10^{-24} D) 1.66×10^{-24}

Answer:C

Solution: Atomic mass of He = 4 amu

1 amu = 1.66×10^{-24}g

$4 \times 1.66 \times 10?^{2}4 = 6.64 \times 10^{-24}$ g

3. Which of the following is the smallest particle of matter that exist independently?

A) Atom B) Molecule C) element D) compound

Answer:B

Solution: Molecules are the smallest particles that exist independently, not atoms.

4. The weight of 1 mole of calcium atoms of an element = _____ grams.

A) 40 g B) 20 g C) 10 g D) 5 g

Answer:A

Solution:Atomic mass of calcium = 40 amu

1 mole = 40 g

5. Gram atomic weight of an element contain _____ number of atoms.

A) 6.023×10^{23} B) 3.0115×10^{23} C) 1.505×10^{23} D) 12.046×10^{23}

Answer:A

Solution:By definition, 1 mole (or gram atomic weight) = Avogadro's number of atoms = 6.023×10^{23}

6. Calculate the weight of nitrogen present in 0.5 moles of NH_3.

(A) 8 g (B) 9 g (C) 1 g (D) 7 g

Answer:D

Solution: 1 mole of NH_3 has 1 N atom = 14 g

0.5 moles = $0.5 \times 14 = 7$ g

7. Calculate the weight in gram of 0.9 gram atoms of zinc.

(A) 50.5 g (B) 58.5 g (C) 56.3 g (D) 53.2 g

Answer:B

Solution: Atomic mass of Zn = 65 g/mol

$0.9 \times 65 = 58.5$ g

8. Calculate the weight of 0.4 gram atoms of carbon.

(A) 2.8 g (B) 4.8 g (C) 3.2 g (D) 4.0 g

Answer:B

Solution:Atomic mass of C = 12 g

0.4 × 12 = 4.8 g

9. What is the weight of 3 gram atoms of sulphur ?

(A) 98 g (B) 99 g (C) 95 g (D) 96 g

Answer:D

Solution:Atomic mass of S = 32 g

3 × 32 = 96 g

10. Calculate the weight of 2.5 mole of $CaCO_3$:-

(A) 200 g (B) 230 g (C) 240 g (D) 250 g

Answer:D

Solution: Molar mass of CaCO3 = 40 + 12 + 48 = 100 g/mol

2.5 × 100 = 250 g

11. The number of moles present in 20 grams of $CaCO_3$ is :-

(A) 0.1 (B) 0.2 (C) 0.3 (D) 0.25

Answer:B

Solution:Molar mass = 100 g/mol

Moles = 20 / 100 = 0.2

JEE MAIN LEVEL QUESTIONS

12. The ratio of number of atoms present in 1 gram of hydrogen to the number of molecules present in 2 gram of hydrogen is :

A) 1 : 2 B) 2 : 1 C) 1 : 1 D) 1 : 3

Answer:C

Solution:1 g of hydrogen (H atoms):

Moles of H = 1/1=1mole

Number of H atoms =1 x N=6.02×10^{23} .

2 g of hydrogen gas (H_2 molecules):

Moles of H_2 = 2/2=1 mole.

Number of H_2 molecules = $1\times N=6.02\times10^{23}$.

Ratio (H atoms : H_2 molecules) = 1:1.

13. The total number of protons in 10 g of calcium carbonate is ($N_0 = 6.02 \times 10^{23}$)

A) 1.5057×10^{24} B) 2.0478×10^{24}

C) 3.0115×10^{24} D) 4.0956×10^{24}

Answer:C

Solution:Molar mass of $CaCO_3$ = 40 (Ca) + 12 (C) + 3×16 (O) = 100 g/mol.

Moles in 10 g = 10/100=0.1 mole.

Protons per $CaCO_3$:Ca: 20 protons, C: 6 protons, O: 8 protons each.

Total = 20+6+3×8=50 protons.

Total protons = $0.1 \times 50 \times 6.02 \times 10^{23} = 3.0115 \times 10^{24}$.

14. How many moles of glucose ($C_6H_{12}O_6$) are present in 5.4 g ?

(A) 0.03 (B) 0.02 (C) 0.01 (D) 0.1

Answer:A

Solution:Molar mass of glucose = 6×12+12×1+6×16=180g/mol.

Moles = 5.4/180=0.03

15. Calculate the number of gram atoms present in 8 g of helium :-

(A) 3 (B) 4 (C) 2 (D) 1

Answer:C

Solution:Atomic mass = 4 g/mol

Gram atoms = 8 / 4 = 2

16. 16 gram of oxygen is equal to :-

(A) 1 gram atom (B) 0.5 gram mole

(C) 2 gram equivalents (D) all of these

Answer:D

Solution:Gram atomic mass of O = 16 g $\rightarrow$ 1 gram atom

Molar mass of O_2 = 32 g $\rightarrow$16 g = 0.5 mol $\rightarrow$0.5 gram mole

Equivalent mass of O_2 = 32/4 = 8 $\rightarrow$ 16/8 = 2 gram equivalents

17. How many moles are present in 5.3 g of anhydrous sodium carbonate ?

(A) 0.03 (B) 0.04 (C) 0.05 (D) 0.01

Answer:C

Solution:Moles = 5.3 / 106 = 0.05 mol

18. Calculate the number of moles present in 60 g of NaOH.

(A) 1.2 (B) 1.5 (C) 2.5 (D) 0.15

Answer:B

Solution:Moles = 60 / 40 = 1.5 mol

19. How many gram atoms are present in 256 g of O_2 ?

(A) 16 (B) 32 (C) 14 (D) 36

Answer:A

Solution:Atomic mass of O = 16

Gram atoms = 256 / 16 = 16

20. How many gram atoms are present in 60 g of carbon ?

(A) 6 (B) 10 (C) 16 (D) 5

Answer:D

Solution:Atomic mass of C = 12

Gram atoms = 60 / 12 = 5

21. Calculate the number of moles present in 7.3 g of HCl.

(A) 0.2 (B) 0.1 (C) 1 (D) 0.02

Answer:A

Solution:Moles = 7.3 / 36.5 = 0.2 mol

ADVANCED LEVEL QUESTIONS

MULTIPLE CORRECT ANSWER TYPE

22. 1 gram molecular volume of a gas is

1) 22.4 litres 2) 22.4dm^3 3) 22400cm^3 4) 42.200cm^3

Answer:1,2,3

Solution:At STP (Standard Temperature and Pressure), 1 mole (gram molecular weight) of any ideal gas occupies:22.4 litres = 22.4 dm^3 = 22400 cm^3

23. 12g of carbon-12 is found to contain

1) 6.023 $X10^{23}$ atoms 2) 12 N electrons

3) 18 N sub-atomic particles 4) 6.625 $X10^{24}$ Aoms

Answer:1,3

Solution:12 g of carbon-12 (C-12) is 1 mole of carbon.

1 mole of C-12 contains:

6.023 × 10^{23} atoms (Avogadro's number, N).

6 electrons per atom $\rightarrow$ Total electrons = 6 × N = 6N.

Sub-atomic particles (protons + neutrons + electrons) per atom:

Protons = 6, Neutrons = 6, Electrons = 6 $\rightarrow$ Total = 18 per atom.

Total sub-atomic particles in 1 mole = 18 × N = 18N.

STATEMENT TYPE

1. A and R are correct R is the correct explanation of A
2. A and R are correct R is not the correct explanation of A

3. A is correct, but R is wrong 4. A is wrong, but R is correct

24. **Assertion (A):** The number of atoms present in gram atomic weight of different elements are equal.

Reason (R): The number of molecules present in gram molecular weight of different substances is equal.

Answer:2

Solution:Assertion (A) is correct:

The gram atomic weight (1 mole) of any element contains Avogadro's number (6.022×10^{23}) of atoms, regardless of the element.

Example: 1 mole of Carbon (12 g) and 1 mole of Oxygen (16 g) both contain 6.022×10^{23} atoms.

Reason (R) is correct but unrelated:

The gram molecular weight (1 mole) of any substance contains 6.022×10^{23} molecules, but this does not explain why gram atomic weights have equal numbers of atoms.

The reason talks about molecules, while the assertion is about atoms in elements (not compounds).

25. **Assertion (A):** 1 a.m.u. = 1.66×10^{-24} g or 1.66×10^{-27} kg.

Reason (R): Atomic weight has no units.

Answer:2

Solution:Assertion (A) is correct:

1 atomic mass unit (a.m.u.) is defined as 1/12th the mass of a carbon-12 atom.

Its value is:1 a.m.u. = 1.66×10^{-24} g or 1.66×10^{-27} kg.

Reason (R) is correct but unrelated:

Atomic weight (relative atomic mass) is a dimensionless quantity (no units) because it is a ratio of the average mass of an atom to 1/12th the mass of a C-12 atom.However, this does not explain why 1 a.m.u. equals the given values.

COMPREHENSION TYPE

$$\text{Relative atomic mass of an element } (\text{RAM}) = \frac{\text{Mass of 1 atom of that element}}{\frac{1}{12} \times (\text{Mass of C-12 atom})}$$

26. The total mass of 100 atoms of silicon is:

A) 2800 B) 2800 amu C) $28 \times 1.66 \times 10^{-22}$g D) Both 2 and 3

Answer:D

Solution:Atomic mass of Silicon (Si) = 28 amu (given in the periodic table).

Mass of 100 Si atoms = 100 × 28 amu = 2800 amu.

Conversion of amu to grams:

1 amu = 1.66×10^{-24} g

2800 amu = $2800 \times 1.66 \times 10^{-24}$ g = $28 \times 1.66 \times 10^{-22}$g (since 2800 = 28 × 100).

27. If the atomic weight of oxygen were taken as 100, then what would be molecular weight of water

A) 18 B) 102 C) 112.5 D) 142.5

Answer:C

Solution:Atomic mass of H = 1, O = 16 $\rightarrow H_2O$ = 2 + 16 = 18

Now, if O is taken as 100 instead of 16,then this is a scaling ratio:

Scaling factor = 100 / 16 = 6.25

Then, molecular weight of H_2O = 18 × 6.25 = 112.5

INTEGER TYPE

28. Volume occupied by 4.4 g of CO_2 in CC is _____

Answer:2240

Solution:Molar mass of CO_2 = 12 (C) + 2 × 16 (O) = 44 g/mol.

Number of moles of CO_2 = Mass / Molar mass = 4.4 g / 44 g/mol = 0.1 moles.

Molar volume of a gas at STP = 22.4 L/mol = 22400 cc/mol (since 1 L = 1000 cc).

Volume occupied by 0.1 moles of CO_2 = 0.1 × 22400 cc = 2240 cc.

29. Number of moles of water present in 720 grams of water is _____

Answer:40

Solution:Molar mass of H_2O = 2 × 1 (H) + 16 (O) = 18 g/mol.

Number of moles of H_2O = Mass / Molar mass = 720 g / 18 g/mol = 40 moles.

MATRIX MATCHING TYPE

30.

List - I	**List - II**
A) 1.008 g of H_2	1) 0.1 gram atom
B) 245 g of $KC\ell O_3$	2) 22.4 litre at S.T.P
C) 71 grams of $C\ell_2$	3) 12.046×10^{23} molecules
D) 10.8 grams of silver	4) 3.0115×10^{23} molecules

Answer:A-4,B-3,C-2,D-1

Solution:

A) 1.008 g of $H_2 \rightarrow$moles=1/2=0.5moles= 3.0115×10^{23} molecules $\rightarrow 4$

B) 245 g of $KC\ell O_3 \rightarrow$moles=245/122.5=2moles=12.046×10^{23} molecules$\rightarrow$3

C) 71 grams of $C\ell_2 \rightarrow$moles=71/71=1mole=2) 22.4 litre at S.T.P$\rightarrow$2

D) 10.8 grams of silver$\rightarrow$moles=10.8/108=0.1moles= 0.1 gram atom$\rightarrow$1

KEY

				TEACHING TASK					
				JEE MAIN LEVEL QUESTIONS					
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2	1	1	1	4	3	2	1	2	4
				ADVANCED LEVEL QUESTIONS					
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	
B	C	**2**	**5**	**3**	**4**	**1**	**5**	**30**	
20									
a-3,b-1,c-4,d-2									
				LEARNER'S TASK					
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
A	C	B	A	A	D	B	B	D	D
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	C	C	A	C	D	C	B	A	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	
A	1,2,3	1,3	2	2	D	C	2240	40	
30									
a-3,b-1,c-4,d-2									